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SHIELDS L. DALTROFF
VICE PRESIDENT
ELECTRIC PRODUCTION

July 6, 1979

Docket Nos.: 50-277
50-278

Re: IE Bulletin 79-02

Mr. Boyce H. Grier, Director
Office of Inspection & Enforcement
Region I
United States Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, PA 19406

Dear Mr. Grier:

This is in response to your letter of June 21, 1979, which forwarded IE Bulletin 79-02 (Revision 1) and included by reference IE Bulletin 79-02, forwarded by your letter of March 8, 1979. The actions requested, and our responses as they pertain to the Peach Bottom Atomic Power Station, Units 2 and 3, are listed sequentially below.

Action to be Taken by Licensee:

1. Verify that pipe support base plate flexibility was accounted for in the calculation of anchor bolt loads. In lieu of supporting analysis justifying the assumption of rigidity, the base plates should be considered flexible if the unstiffened distance between the member welded to the plate and the edge of the base plate is greater than twice the thickness of the plate. It is recognized that this criterion is conservative. Less conservative acceptance criteria must be justified and the justification submitted as part of the response to the Bulletin. If the base plate is determined to be flexible, then recalculate the bolt loads using an appropriate analysis. If possible, this is to be done prior to testing of anchor bolts. These calculated bolt loads are referred to hereafter as the bolt design loads. A

description of the analytical model used to verify that pipe support base plate flexibility is accounted for in the calculation of anchor bolt loads is to be submitted with your response to the Bulletin.

Response

The flexibility of the base plate was not considered in the design of the Seismic Category I pipe supports.

All pipe anchor and support base plates using expansion anchor/bolts were (re) analyzed to account for plate flexibility, bolt stiffness, shear-tension interaction, minimum edge distance and proper bolt spacing. Depending on the complexity of the individual base plate configuration one of the following methods of re-analysis was used to determine the bolt forces:

(1) A quasi analytical method, developed by Bechtel Power Corporation was used for base plates with eight bolts or less. A review of the typical base plates used in supporting the subject piping systems indicate that the majority of them were anchored either by 4, 6 or 8 bolts. The plate thicknesses vary from 1/2" to 2" and are not generally stiffened. For these types of base plates an analytical formulation has been developed which treats the plates as a beam on multiple spring supports subjected to moments and forces in three orthogonal directions. Based on analytical considerations as well as the results of a number of representative finite element analyses of base plates (using the "ANSYS" Code), certain empirical factors were introduced in the simplified beam model to account for (a) the effect of concrete foundation (b) the two way action of load transfer in a plate. These factors essentially provided a way for introducing the interaction effect of such parametric variables as plate dimensions, attachment sizes, bolt spacings and stiffness on the distribution of external loads to the bolts.

The results of a number of case studies indicated excellent correlation between the results of the present formulation and those by the Finite Element Method (using the "ANSYS" Code). The quasi analytical method generally gives the bolt loads greater than the Finite Element Method.

A computer program for the analytical technique described above has been implemented for determining the bolt loads for routine applications. The program requires plate dimensions, number of bolts, bolt size, bolt spacing, bolt stiffness, the applied forces and the

allowable bolt shear and tension loads as inputs. The allowable loads for a given bolt are determined based on the concrete edge distance, bolt spacing, embedment length, shear cone overlapping, manufacturer's ultimate capacity, and a design safety factor. The program computes the bolt forces and calculates a shear-tension interaction value based on the allowable loads.

(2) For special cases where the design of the support did not lend itself to the foregoing method, the finite element method using the "ANSYS" code and/or other standard engineering analytical techniques with conservative assumption were employed in the re-analysis.

(3) Other cases were solved using an approach based on the strength design method given in the ACI 318-77 code.

2. Verify that the concrete expansion anchor bolts have the following minimum factor of safety between the bolt design load and the bolt ultimate capacity determined from static load tests (e.g., anchor bolt manufacturer's) which simulate the actual conditions of installation (i.e., type of concrete and its strength properties):

a. Four - for wedge and sleeve type anchor bolts.
b. Five - for shell type anchor bolts.

The bolt ultimate capacity should account for the effects of shear-tension interaction, minimum edge distance and proper bolt spacing.

If the minimum factor of safety of four for wedge type anchor bolts and five for shell type anchors can not be shown then justification must be provided.

Response

The calculated bolt design loads are being compared to the manufacturer's published ultimate capacities adjusted to the conditions existing at Peach Bottom to verify the adequacy of the existing factors of safety. Of the 1217 supports re-analyzed for the operating and seismic loading (Design Basis Earthquake), 1125 have factors of safety exceeding 5 in the maximum stressed bolt, and 92 have factors of safety less than 5. The pipe support drawings indicate that self-drilling shell type anchors were generally used.

The following summarizes the distribution of these 92 supports previously reported in LER 2-79-32/1T and the factors of safety:

Factor of Safety	No. of Supports
4 to 5	20
3 to 4	27
2 to 3	24
1 to 2	13
Less than 1	8

Modifications are being made to the 21 supports having a bolt safety factor less than 2, and are expected to be completed by July 31, 1979. In the cases when extreme environmental loads are included, a factor of safety of at least three is used for acceptance in accordance with Section B.7.2 of the Proposed Addition to Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-76) August, 1978. In cases where the factor of safety exceeds two (but is less than three), a program of 100% verification of acceptable anchor bolts will be implemented.

3. Describe the design requirements if applicable for anchor bolts to withstand cyclic loads (e.g., seismic loads and high cycle operating loads).

Response

In the original design of the piping systems Bechtel Power Corporation considered deadweight, thermal stresses, seismic loads, and dynamic loads in the generation of the pipe support design loads. To the extent that these loads include cyclic considerations, these effects are included in the design of the hangers, base plates and anchorages.

The safety factors used for concrete expansion anchors, installed on supports for safety related piping systems, were not increased for loads which are cyclic in nature. The use of the same safety factor for cyclic and static loads is based on the Fast Flux Test Facility Tests. (Drilled - In Expansion Bolts Under Static and Alternate Loads. Report No. BR 5853-C-4 by Bechtel Power Corp., January, 1975). The test results indicate:

1) The expansion anchors successfully withstood two million cycles of long term fatigue loading at a maximum intensity of 0.20 of the static ultimate capacity. When the maximum load intensity was steadily increased beyond

the aforementioned value and cycled for 2,000 times at each load step, the observed failure load was about the same as the static ultimate capacity.

2) The dynamic load capacity of the expansion anchors, under simulated seismic loading, was about the same as their corresponding static ultimate capacities.

4. Verify from existing QC documentation that design requirements have been met for each anchor bolt in the following areas:

(a) Cyclic loads have been considered (e.g. anchor bolt preload is equal to or greater than bolt design load). In the case of the shell type, assure that it is not in contact with the back of the support plate prior to preload testing.

(b) Specified design size and type is correctly installed (e.g. proper embedment depth).

If sufficient documentation does not exist, then initiate a testing program that will assure that minimum design requirements have been met with respect to sub-items (a) and (b) above. A sampling technique is acceptable. One acceptable technique is to randomly select and test one anchor bolt in each base plate (i.e. some supports may have more than one base plate). The test should provide verification of sub-items (a) and (b) above. If the test fails, all other bolts on that base plate should be similarly tested. In any event, the test program should assure that each Seismic Category I system will perform its intended function.

Response

Philadelphia Electric Company has initiated a testing and inspection program. This program is currently under way at the Peach Bottom Atomic Power Station. Testing and inspection will be done on all Seismic Category I piping systems, with the exception of small piping (2 1/2" diameter or less) which was chart analyzed. Based on the conservativeness of this analysis, system operability is not compromised, and small piping supports have not been included in the testing program.

Also excluded from the testing and inspection program are those supports which re-analysis indicates that under design

loading conditions, none of the bolts are subject to tensile loads.

The testing and inspection program will verify that:

a) The installed anchor is the proper diameter and an acceptable type.

b) Preload in the anchor bolt is verified by the application of the a specified torque to the bolt. Attainment of specified torque will verify that the bolt preload is in excess of the bolt design load. Testing is being done on one bolt in each base plate. Should the specified test torque not exist in the bolt tested, that bolt shall be torqued to the specified value, and the remaining bolts tested in a similar manner. To assure validity of the torque test on shell type anchors, it shall be verified that shell to base plate contact does not exist. The specified test torque values have been developed by Bechtel Power Corporation and represent a bolt preload not less than 25% of the manufacturer's published ultimate load. Site specific torque-tension relationships are being developed based on testing performed at the site.

c) Bolts are of sufficient length to assure adequate thread engagement for shell type anchors, and proper embedment of wedge type anchors in the concrete.

It has been determined that there are no Seismic Class I supports requiring anchor bolt testing in areas which are not accessible during unit operation. The balance of the Seismic Class I systems are normally accessible for inspection during operation.

Up to June 29, 1979, testing has been completed on 5% of the supports requiring testing. Of a total of 150 concrete expansion bolts tested to date, 7 have failed to meet the specified torque requirements, and necessary corrective action has been taken. Bechtel Power Corporation will review for structural adequacy any support in which an expansion bolt fails to meet test criteria. Corrective actions required as a result of testing are being done in an expeditious manner. In cases where insufficient thread engagement is found, a bolt of sufficient length is being installed to provide adequate thread engagement. Where expansion bolts fail to develop the specified torque, or fail by pull-out, these bolts will be removed and replaced with new expansion bolts. As other problems arise, these are being reviewed on a case-by-case basis, and modifications made as required.

The testing and inspection of Seismic Class I piping system supports anchored with expansion bolts in being done to assure adequacy of support and operability of each Seismic Category I piping system. During the testing and inspection program, system operability is maintained by limiting removal of one bolt at a time from any base plate. This restriction also applies when it may become necessary to replace an expansion bolt.

The safety and operability of the Seismic Category I piping systems will not be compromised during the testing and inspection program now being implemented. Upon completion of the program, it will have been verified that expansion anchor bolts installed at Peach Bottom have pre-load exceeding bolt design loads. Improperly installed bolts will have been replaced where necessary, or by engineering analysis, the remaining acceptable bolts in a support plate shall have been demonstrated to be adequate to sustain design loads. Where necessary, modifications will have been made to supports to assure safety and operability of the Seismic Class I piping systems.

A final report will be issued when the testing and inspection program is completed as required by the Bulletin. The entire testing and inspection program, including any modifications required, is expected to be completed by December 31 1979.

Should you have any questions or require additional information, please do not hesitate to contact us.

Very truly yours,

cc: United States Nuclear Regulatory Commission
Office of Inspection and Enforcement
Division of Reactor Operations Inspection
Washington, DC 20555